Title: The effect of Pain Neurophysiology Education on Sports Therapy and Rehabilitation students' Knowledge, Attitudes and Clinical Recommendations towards Athletes with Chronic Pain

Running title: Pain education for Sports Therapy and Rehabilitation students' knowledge, attitudes and rehabilitation recommendations.

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No funding was received for this trial.

ABSTRACT

Context: Pain education is a fundamental part of a holistic approach to athlete injury management.

Objective: Investigate the effect of Pain Neuroscience Education (PNE) on Sports Therapy and Rehabilitation (STR) students: 1) knowledge of persistent pain; 2) attitudes towards athletes with persistent pain; 3) clinical recommendations for athletes with persistent pain.

Design: Parallel groups, single-blind randomised control trial.

Setting: A UK University.

Participants: Sixty-one undergraduate and postgraduate STR students

Interventions: The PNE session (intervention group) provided detailed information on the neuroscience of persistent pain, the modulating role of psychosocial factors on pain biology, and how this information could be used to inform clinical practice. The red flags (control group) session provided information on screening patients with persistent pain for serious/sinister pathologies. Each education session lasted 70 minutes.

Outcome measures: (1).Knowledge - the Revised Pain Neuroscience Questionnaire; (2). Attitudes – the Health Care Pain Attitudes and Impairment Relationship Scale (HC-PAIRS); (3). Clinical recommendations – an athlete case vignette.

Results: Post education, the PNE group had a greater increase in pain neuroscience knowledge (mean difference 3.2 [CI 2.1 to 4.3], $p<0.01$) and improved attitudes (mean difference -10.1 [CI -16.6 to -3.6], $P<0.01$). Additionally, students in the PNE group were more likely to make appropriate clinical recommendations (OR = odds ratio, CI = confidence interval) regarding return-to-work (OR 6.1 [CI 1.1 to 32.3], $p=0.03$), exercise (OR 10.7 [CI 2.6 to 43.7], $p=<0.01$), and bed rest (OR 4.3 [CI 1.5 to 12.8], $p=0.01$).

Conclusions: A brief PNE session can, in the immediate term, increase STR students' knowledge of pain neuroscience, improve attitudes towards athletes with pain and shift their clinical recommendations in line with current guidelines. Such changes could lead to enhanced rehabilitation for athletes with persistent pain.

INTRODUCTION

Up to 65% of athletes will experience low back pain during their career[1]. Recent research has highlighted that psychological factors including anxiety, stress and low mood are collective predictors of injury chronicity for athletes[2]. Owing to this, recent calls have been made to approach athlete rehabilitation from a biopsychosocial perspective[3]. This treatment advice is also replicated in the general population, with National Institute for Health and Care Excellence[4] recommending pain education be included to improve clinical outcomes.

Sports Therapy and Rehabilitation is an aspect of healthcare, with a sport and exercise perspective, concerned with the prevention of and rehabilitation from injury through physical and exercise therapy. Thus, contemporary pain education at pre-registration level for sports therapists and rehabilitators (STR) is a logical prerequisite to delivering evidenced based practice post-registration.

For traditional healthcare professional courses, both the quality and quantity of pain education has been questioned[5]. A recent UK survey found that on average, across a range of undergraduate healthcare degrees (not including STR), less than 1% of the total curriculum was allocated to pain education[5]. Evidence assessing the provision of pain education on STR related courses is lacking, however, the importance of contemporary education in this profession is high. Adequate provision of pain education at STR undergraduate level could support the call made by Puentadura and Louw[3] to improve athlete rehabilitation. Noll et al.,[6] suggest structured education and the identification of psychosocial barriers can improve athletic performance.

With the importance attributed to pain education amongst the athletic population, it is imperative that STR pre-registration pain education methods are evaluated.

A particular model of pain education is pain neuroscience education (PNE). Pain neuroscience education has primarily been used as an intervention for patients with chronic pain. Pain neuroscience education uses current understanding of neuroscience to help reconceptualise the experience of pain. The aim is to highlight that, although pain is a very real experience, it can be an over protective mechanism, even in the absence of tissue damage. In addition to patients, PNE has been used to improve knowledge for clinicians[7] and physiotherapy students[8]. A recent randomised control trial[8], reported that a 70 minute PNE session for undergraduate physiotherapy students improved pain neurophysiology knowledge, improved attitudes and increased the likelihood of delivering appropriate treatment recommendations to patients with chronic pain. Given the prevalence of low back pain in the athletic population the research into the merits of PNE for STR students is warranted.

Therefore the aim of this study was to investigate the effect of Pain Neuroscience Education (PNE) on STR students 1) knowledge of persistent pain; 2) attitudes towards athletes with persistent pain; 3) clinical recommendations for athletes with persistent pain.

METHODS

Design

In this parallel group, single blind randomised control trial (RCT) participants were randomly assigned to receive either pain neuroscience education (PNE) or control education (red flags education). Three outcome measures were analysed before, and after both education sessions. Outcome measures were; the revised Pain Neurophysiology Education Questionnaire[9]; the Modified Health Care Pain Attitudes and Impairment Relationship Scale (HC-PAIRS)[10], and a case vignette to measure practical clinical recommendations[11].

106

107 **Participants**

108 Students were eligible to take part in the proposed study if they were enrolled on the first year
109 of the (BSc) Sports Therapy and Rehabilitation undergraduate course or the (MSc) Sports
110 Rehabilitation postgraduate pre-registration at Teesside University, United Kingdom. A total
111 of 84 students were approached to take part in this study (BSc n=67, MSc n=17). Participants
112 were excluded from the study if they had previously received formal teaching of pain
113 neuroscience. Year 2 and 3 students receive education on the mechanism of pain as part of their
114 first year curriculum and therefore were not eligible to participate. All pre-registration MSc
115 postgraduate students receive pain education as part of their one-year curriculum, therefore the
116 intervention education sessions took place during their university induction week, before formal
117 modules began. All participants provided written informed consent prior to each of the
118 proposed education conditions. Students were invited to participate in the study via a grouped-
119 cohort email invitation and via a brief oral presentation of the study). The trial was registered
120 with ClinicalTrials.gov (Trial ID NCT03002181), conducted in accordance with the
121 Declaration of Helsinki, (1975), and reported in accordance with CONSORT standards. The
122 Teesside University Research Ethics Board provided ethical approval prior to the study
123 commencing.

124

125 **Procedures**

126 Student participants were randomised into either the PNE intervention group or the red flag
127 control group via the random number generator function of Microsoft Excel™ (Office
128 Professional Plus 2013). A coin was then tossed to allocate which of these two groups received
129 the PNE session. Participants were informed that the primary intention of the study was to
130 compare two modes of pain education. Knowledge of their education assignment was not
131 provided to the participants prior to the sessions so as not to influence outcomes and/or
132 attendance. For ethical purposes, the intervention group received red flag content the following

133 academic week, with the control group receiving the PNE content. The lead author carried out
134 the allocation of the participants to each group prior to meeting any of the participants. This
135 process was concealed from the educator who had no involvement in allocation.
136
137 **Interventions.**
138 Both PNE and red flag education sessions were delivered in a lecture theatre at Teesside
139 University by a qualified physiotherapist with extensive experience of teaching pain
140 neuroscience at degree and postgraduate degree level. Each session lasted 70 minutes, with
141 approximately 10 minutes pre and post education allocated to complete the outcome
142 questionnaires. Each education condition was delivered in a didactic lecture style format, using
143 PowerPoint™ presentation. The education sessions were given immediately after each other to
144 minimise the possibility of contamination of material between education groups.
145
146 The intervention group received one PNE session. This session contained information about
147 the science of neural pathways in relation to the experience of pain, including events such as;
148 depolarization, synapsis, secondary sensitization, hyperalgesia, descending modulation and the
149 potential influence of psychological factors on pain neuroscience and experience. The material
150 for this session was closely mapped to the contents of the '*Explain Pain'* publication[13]. The
151 objective of this session was to educate students that pain can be overprotective, and that
152 nociceptive transmission can be heavily influenced by central sensitisation (sensitivity of the
153 central nervous system) as well as the thoughts and beliefs of the individual. The session used
154 drawings, stories and metaphors, as found in *Explain Pain*[13] to depict the underlying
155 neuroscience of pain, and current pain theory. The control group received an education session
156 of red flags. Red flags form part of routine subjective practice for therapists as a process of
157 screening serious or potentially sinister pathologies[12]. Sign and symptoms for such pathologies
158 include history of cancer, systemic symptoms such as fever or unexplained weight loss, and
159 saddle analgesia. The use of red flag screening is advocated by the National Institute for Health
160 and Care Excellence[4]. The red flag session did not include the neuroscience of pain.

Outcomes Measures

Both immediately pre-and post-education session, all participants completed 4 questionnaires; the Revised Pain Neurophysiology Questionnaire, The Modified Health Care Pain Attitudes and Impairment Relationship Scale (HC-PAIRS), a clinical vignette and a red flags questionnaire. The red flags questionnaire has been devised for the purposes of this study as there is currently no validated questionnaire that exists within the literature. The questionnaire was not used as an outcome measure in the current study, but rather as a vehicle to further facilitate participant blinding. Adverse effects to the intervention and/or control were monitored using passive surveillance.

Revised Pain Neurophysiology Questionnaire

The questionnaire has 13 items to be answered true, false or undecided. Undecided responses were awarded 0 points, whilst correct answers were awarded one point. Scores range from 0-13, with higher scores indicating higher levels of pain neuroscience knowledge. The Revised Pain Neurophysiology Questionnaire is a valid and reliable measure of pain neuroscience knowledge[9].

HC-PAIRS

HC-PAIRS is a 13-item questionnaire. Each item has a 7-point likert scale ranging from strongly agree (7 marks), to strongly disagree (1 mark). Scores therefore range from 13 to 91, with lower scores representative of more positive attitudes towards athletes with chronic pain, and higher scores representative of more negative attitudes. For the purposes of this study, each item referred to an ‘athlete’, rather than ‘patient’. The Health Care Pain Attitudes and Impairment Relationship Scale has been found to be a valid and reliable measure of therapist attitude towards patients with chronic pain[14].

188 **Case Vignette**

189 A case study was given to each participant to assess their clinical recommendation for an athlete
190 with chronic pain (Table 1). The vignette was adapted from previously published vignettes[8, 15,
191 16]. Participants were requested to demonstrate their recommendations to athletes regarding daily
192 activities, exercise, work and bed rest via 4 multiple choice questions. Outcome measures were
193 calculated as number and percentage of appropriate recommendations in line with current
194 clinical guidelines[16]. Vignettes have previously been utilised for the purposes of assessing
195 clinical recommendations in management of patients with chronic low back pain[14,18] and have
196 been shown to be an accurate measure of clinical behaviour[11].

197

198 **Table 1 - Case vignette recommendation options.**

199 ***INSERT TABLE 1 HERE***

200

201 **Statistical Analysis**

202 All data was analysed using SPSS, version 23. Prior to statistical analysis, frequency tables
203 were drawn to screen for miscoding. Group identification was concealed during the data
204 analysis to assist with blinding. Continuous data were presented as mean (SD), and categorical
205 data presented as percentages. Mean difference in change between groups was analysed using
206 an analysis of covariance (ANCOVA). Covariates were baseline PNE, HC-PAIRS and red flag
207 scores, level of education, gender and age. Baseline values for clinical recommendations were
208 established prior to, and values re-assessed following the respective education sessions.
209 Contingency tables were drawn detailing the change in appropriate recommendations as the
210 dependent variable, and education group as the independent. The Mantel-Haenszel test was
211 used to establish the odds ratios and their 95% confidence limits for appropriate
212 recommendations following each of the two education conditions. Statistical significance was
213 set at 0.05.

RESULTS

Sixty-one (61/84) students representing 72% of the target population volunteered (n=45 BSc, n=16 MSc) for the study and were subsequently randomised. Thirty-five participants received the PNE intervention, and 26 received the control education. The characteristics of the 61 participants are presented in table 1. Table 1 highlights differences in randomised groups at baseline. The PNE group was made up of 89% BSc students, 63% of which were female. The control group in comparison was made up of 54% BSc students. For all outcome measures, there were no participant losses after randomising.

Table 1. Participant characteristics at baseline.

INSERT TABLE 2 HERE

Table 3. Within group change for all outcome measures.

INSERT TABLE 3 HERE

The group who received the PNE condition had greater increases in pain knowledge (mean difference 3.2 (CI 2.1 to 4.3), p<0.01) and in attitudes towards athletes with chronic pain (mean difference -10.1 (CI -16.6 to -3.6), P<0.01) table 3. In addition, post intervention/control the PNE group were consistently more likely to make appropriate clinical recommendations (table 4), in line with current clinical guidelines, for return to work (OR 6.1 (CI 1.1 to 32.3), p=0.03), exercise (OR 10.7 (CI 2.6 to 43.7), p=<0.01), daily activities (OR 3.2 (CI 0.9 to 11.0), p=0.07) and bed rest (4.3 (CI 1.5 to 12.8), p=0.01). Table 4 highlights pre and post scores for each outcome measure. In addition, and for complete reporting, the red flags questionnaire findings have also been reported (tables 2 and 3) however, this component of the methods was implemented to strengthen participant blinding rather than to be used as an outcome measure in itself. Zero participants reported any adverse effects.

Table 4. Change in knowledge and attitudes between groups.

INSERT TABLE 4 HERE

Table 5. Appropriate clinical recommendations post education.

INSERT TABLE 5 HERE

DISCUSSION

Pain education is a fundamental as part of the holistic management of the injured athlete. A key finding of this study was that STR students' knowledge of pain neuroscience and their attitudes towards athletes with chronic pain improved following a 70-minute PNE session compared to a control education. Concurrently, students who received PNE also demonstrated a positive change in clinical recommendations for pain management, in line with current guidelines, in comparison to the control group.

The current study reported a 25% improvement in pain neuroscience knowledge following the PNE intervention compared to a -1.5% change in the control group. These findings are comparable to the 23% increase (55% - 78%) in health care professionals, and the 32% increase (29% - 61%) in patients'[7]. A 45% increase in PNE knowledge was reported for doctoral physical therapy students in an uncontrolled study[19]. More recently, Collearya et al.,[8] (2017) using controlled methods, reported a 34% improvement in the PNE knowledge of undergraduate physiotherapy students. These findings suggest that a PNE intervention can, in the immediate term, improve STR students' knowledge of complex pain physiology to a level similar to qualified healthcare professionals.

The PNE group in the current study saw a 15-point improvement in HC-PAIRS score compared with a control group improvement of 4.7 points. Currently, there is no consensus on minimally important clinical difference for change in attitudes following an intervention of this kind.

However, context is provided by Morris et al.,[20], who reported a 9-point improvement in medical student attitudes (as measured by the HC-PAIRS) across the course of their 5-year medical training. HC-PAIRS scores reported in our study are comparable to Colleary et al.,[8] who reported an 18-point HC-PAIRS improvement following a PNE session of the same length for physiotherapy students. These findings suggest that a PNE session with a short duration (70 minutes) can be effective in improving student attitudes towards patients with chronic pain, above the reported improvement across the duration of a medical degree[20].

The current study found that immediately following the PNE intervention students were more likely to make clinical recommendations that were in line with current clinical guidelines on managing athletes with chronic pain. The increased likelihood of correct recommendations is evident across all four recommendation areas. Ninety four percent, 91%, 86% and 66% percent of the PNE group provided appropriate clinical recommendations for return to work, taking part in structured exercise, undertaking activities of daily living and recommendations for best rest respectively (control group = 73%, 50%, 65% and 31%). The aforementioned study by Colleary et al.,[8] reported comparable results of 94% (work), 92% (exercise), 94% (daily activities) and 69% (bed rest) following a brief PNE intervention. These findings suggest that a 70-minute PNE session can, in the immediate-term, improve STR students' clinical recommendations for athletes with chronic pain. Interestingly, a survey of qualified UK physiotherapists and general practitioners[15] reported appropriate recommendations of 93%, 72% and 99% for work, daily activities and bed rest respectively. This therefore indicates that a condensed 70-minute PNE session for first year STR students can improve their clinical recommendations to a standard comparable with registered and practicing health care professionals.

Clinical and Academic Implications

The improvements in three key outcomes found in the current study may have important clinical implications for rehabilitation within the elite or recreational sports setting by increasing the likelihood of qualified STR providing evidence based practice for chronic pain conditions.

297 Implementing such an education strategy has the potential to improve clinical outcomes in
298 athletes with chronic pain conditions
299
300 A potential confounding variable in the current study was group variance at base line with
301 respect to sex and level of study (table 2). Participants were assigned to groups randomly, and
302 the cause of the variance is unclear. It was possible that some participants may have chosen to
303 attend a different lecture to the one they were randomised to for personal convenience, thus
304 interfering with the random allocation. As participants took part anonymously, it was not
305 possible to confirm or deny that this occurred. To overcome the variance at baseline, the
306 statistical model used adjusted for sex and level of study as a covariate.
307
308 The use of vignettes to assess participant clinical behavior and reasoning is a proxy measure,
309 and not actual clinical observation, which is considered gold standard. However, evidence
310 endorses vignettes as a robust measure of behaviour[11]. In addition, true clinical observation was
311 not possible in the current study as students are only able to practice under direct supervision,
312 compounding the ability to assess individual clinical behaviour.
313
314 Lastly, this study has collected outcome measures immediately following the intervention
315 education sessions. Thus, caution is advised when generalising the findings beyond this period.
316 Future work should include long-term follow up measures in order to assess long term retention
317 of effect.
318
319 A strength of the PNE programme, and perhaps most pertinent to education institutions, was its
320 limited use of resources. A 70-minute PNE session delivered by a qualified lecturer, in a
321 didactic style using PowerPoint has had a positive impact on three key measurement outcomes.
322 This highlights a potential for PNE to be integrated into the current sport therapy and
323 rehabilitation curriculum, though feasibility research is required to investigate this further.
324

CONCLUSION

The current study found that a brief 70-minute session of PNE can, in the immediate-term, increases STR students' knowledge of pain neuroscience, improve their attitudes towards athletes with chronic pain, and improve their clinical recommendations in line with current guidelines. This potentially has future clinical implications for the enhancement of chronic pain rehabilitation within the elite or recreational sports setting through improved pain teaching at undergraduate level. Future research should investigate the long-term effects of PNE on STR students as they move into fully qualified clinical practice with particular attention to the effect on actual clinical behaviour.

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Table 2. Case vignette recommendation options.

Question	Response option on questionnaire	Classification of Response
Work	Return to normal work	Appropriate recommendation
	Return to part-time or light duties	
	Be off work for a further……..weeks (stating number of weeks)	Inappropriate recommendation
	Be off work until pain has improved	
	Be off work until pain has completely disappeared	
Exercise	Return to normal exercise routine	Appropriate recommendation
	Return to light class participation	
	Refrain from participating for a further…….weeks (stating number of weeks)	Inappropriate recommendation
	Refrain from participating until pain has improved	
	Refreain from participating until pain has completely dissappeared	
Activity	Perform usual activites	Appropriate recommendation
	Perform activities within patients tolerance	
	Perform only pain free activities	Inappropriate recommendation
	Limit all physical activities until pain disappears	
Bed Rest	Avoid resting in bed entirely	Appropriate recommendation
	Avoid resting in bed as much as possible	
	Rest in bed only when pain is severe	Inappropriate recommendation
	Rest in bed until pain improves substantially	
	Rest in bed until pain disappears	

Legend: The above table shows the clinical recommendation options following the case vignette. Recommendations were required for work, activity, exercise and bed rest. The first two options for each category are considered appropriate. The remaining recommendations are considered inappropriate options.

Table 3. Participant characteristics at baseline.

	Group	
	PNE	Control
Age	21 (8)	22 (4)
Sex (male/female)	13(37%)/22(63%)	18(69%)/8(31%)
Level (BSc / MSc)	31(89%)/4(11%)	14(54%)/12(46%)
PNE Quiz (0-13)	4.9 (1.6)	5.3 (1.6)
HC-PAIRS (13-91)	55.9 (6.6)	56.4 (8.6)
Red Flags (0-10)	4.9 (1.3)	4.4 (1.5)
Appropriate Clinical Recommendations		
Work (n, %)	22 (63%)	10 (38%)
Exercise (n, %)	17 (49%)	12 (46%)
Daily Activity (n, %)	13 (37%)	13 (50%)
Bed Rest (n, %)	11 (31%)	4 (15%)

Legend: PNE = Pain Neurophysiology Education, HC-PAIRS = Health Care Pain Attitudes and Impairment Relationship Scale. All data are presented as means (SD) except for sex and clinical recommendations. Clinical recommendations are presented as number of participants (and percentage of group) providing appropriate recommendations for work, exercise, daily activity and bed rest.

Table 3. Within group change for all outcome measures.

		Pre	Post	Difference	p-value
PNE Group					
Knowledge		4.9	8.3	3.3	<0.001
Attitudes		55.9	40.7	15.1	<0.001
Recommendations	Work	2.7	1.6	1.1	0.001
	Exercise	3.1	1.8	1.3	<0.001
	Daily Activities	2.7	1.7	1.0	0.032
	Bed Rest	3.0	2.2	0.8	0.379
Control Group					
Knowledge		5.3	5.1	0.2	0.478
Attitudes		56.4	51.7	4.7	0.058
Recommendations	Work	3.2	2.3	0.9	0.007
	Exercise	3.1	2.7	0.4	0.631
	Daily Activities	2.5	2.2	0.1	0.679
	Bed Rest	2.2	3.0	0.8	0.930

Legend: This table highlights the within group change for both the intervention group (PNE) and the control group. Significance for continuous data (knowledge and attitudes) was calculated using paired t-test. Significance for categorical data (clinical recommendations) was calculated using chi-square test for independence.

Table 4. Change in knowledge and attitudes between groups.

	Group		Mean Difference (CI 95%)	p-value
	PNE	Control		
PNE Q	3.3 (2.5)	-0.2 (1.6)	3.2 (2.1 to 4.3)	<0.01
HC-PAIRS	-15.1 (12.3)	-4.7 (12.2)	-10.1 (-16.6 to -3.6)	<0.01
Red Flags	0.3 (1.4)	1.5 (2.5)	-0.8 (-0.3 to 1.8)	0.12

Legend: PNE = Pain Neurophysiology Education, HC-PAIRS = Health Care Pain Attitudes and Impairment Relationship Scale. Change in pain knowledge and attitude towards patients with chronic pain from baseline measurement to post intervention. CI 95% = 95% Confidence Interval. 95% CI and p-value were calculated when adjusted for baseline values, sex and level of education.

Table 5. Appropriate clinical recommendations post education.

	Appropriate Recommendations n (%)			95% Confidence	
	PNE	Control	OR	Interval	p-value
Work	33 (94)	19 (73)	6.1	1.1 to 32.3	0.03
Exercise	32 (91)	13 (50)	10.7	2.6 to 43.7	<0.01
Daily Activities	30 (86)	17 (65)	3.2	0.9 to 11.0	0.07
Bed Rest	23 (66)	8 (31)	4.3	1.5 to 12.8	<0.01

Legend: Table lists the number and percentage of appropriate recommendations within each group. PNE = Pain Neurophysiology Education group. OR = Odds Ratio.